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# Walla Walla Wastewater Treatment Plant/Mill Creek Receiving Water Survey, February 12-13, 1986 and TMDL Evaluation

by

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## ABSTRACT

A post-upgrade Class II and receiving water study were performed at the Walla Walla WTP and Mill Creek in February 1986. Equipment and process malfunctions reduced the WTP performance. Despite these problems, water quality in Mill Creek below the WTP met Class A and B criteria. Comparisons with a 1981 receiving water survey indicated the plant now prevents instream ammonia and chlorine toxicity problems below the plant. The dissolved oxygen (D.O.) profile below the plant also improved. The WTP effluent continues to elevate nitrogen and phosphorus levels in the creek which may cause far-field eutrophication problems. The 1981 total maximum daily load (TMDL) evaluation was reviewed. Changes in plant operation and NPDES permit limits suggested by the 1981 TMDL evaluation continue to adequately protect Mill Creek against D.O. and ammonia toxicity violations. However, instream ammonia toxicity may become a problem when the plant reaches its maximum discharge capacity.

## INTRODUCTION

A receiving water survey was conducted February 11-12, 1986, on Mill Creek in the vicinity of the Walla Walla wastewater treatment plant (WTP). The survey was conducted concurrently with a Class II inspection of the WTP (Heffner, 1986). Receiving water survey personnel included Larry Peterson of the Ecology Eastern Regional Office (ERO) and Pat Crawford and Joe Joy of the Water Quality Investigations Section (WQIS).

The ERO requested this Class II and receiving water survey to:

- Document the water quality of Mill Creek since the upgrade of Walla Walla WTP.

- Compare current conditions to the 1981 pre-upgrade water quality conditions.

The Walla Walla WTP directly discharges into Mill Creek only during winter and early spring months. Prior to 1983, the WTP discharged effluent into Mill Creek from October 15 to April 15. Effluent was diverted to the Blalock and Gose Irrigation Districts the rest of the year. The irrigation districts use the water as needed and waste the rest into Doane, Cold, and Mill Creeks (Figure 1).

In a 1981 receiving water study, Singleton and Joy (1982) noted that ammonia and residual chlorine effluent components degraded Mill Creek water quality. In addition, they reported that poor regulation of upstream flows, poor coordination and timing of wastewater diversion to the irrigation district, and wastewater returns from the district created potentially harmful situations to Mill Creek fish populations. A dissolved oxygen (D.O.) computer model was also created to simulate the D.O. profile below the WTP during different discharge conditions. The simulations suggested effluent ammonia concentrations were a

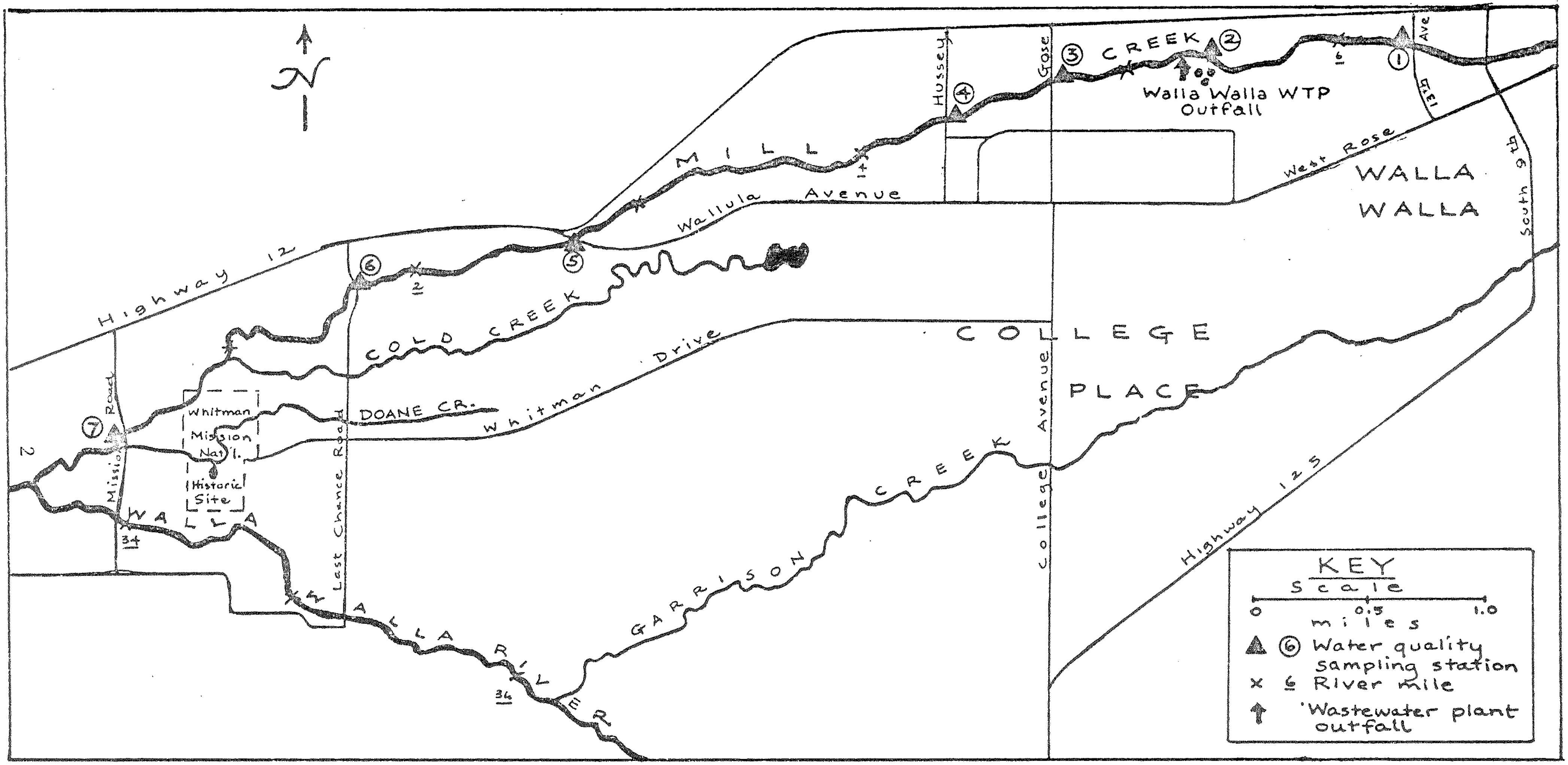


Figure 1. Water quality monitoring stations on Mill Creek near the Walla Walla wastewater treatment plant (WTP), February 12-13, 1986.

primary component affecting downstream D.O. concentrations. Reducing the allowed seasonal discharge period to Mill Creek from October 1 - May 1, to December 1 - May 1, was recommended.

A WTP upgrade was undertaken and completed in 1983. Major structural changes included (Heffner, 1986):

- Improved headworks and primary clarifiers.
- Removal of standard rate trickling filter, dosing siphon, and intermediate clarifier allowing the entire flow to pass through a two-stage trickling filter system.
- Addition of a mixed media polishing filter.
- An improved chlorine contact chamber including dechlorination.

The NPDES permit for the Walla Walla WTP was also modified in 1983. Current permit effluent limits are presented in Table 1. Permit modifications included:

- The seasonal discharge period to Mill Creek was shortened from October 1 - May 1, to December 1 - May 1.
- Influent and final effluent are monitored for ammonia, nitrate, and nitrite although their concentrations are not limited by the permit.

Mill Creek in the vicinity of Walla Walla has been previously described (Singleton and Joy, 1982) (Figure 1). The creek above the WTP above river mile (r.m.) 6.4 is designated Class A; below r.m. 6.4 it is Class B with a special condition that D.O. concentrations exceed 5.0 mg/L: WAC 173-201-80(62-63). Class A and B water quality criteria are presented in Table 2.

Ecology has not routinely monitored Mill Creek water quality since 1975 (Ecology, 1986). However, USGS and the Army Corps of Engineers have continued to maintain a streamflow gage on Mill Creek at r.m. 10 (Station 14015000) since 1943 (USGS, 1985).

## METHODS

Descriptions and field/laboratory activities for individual stations are listed in Table 3. Monitoring locations are shown in Figure 1.

Field analyses included: temperature by mercury thermometer, D.O. by Winkler-azide modified titration, pH and conductivity by field meters, and total residual chlorine (TRC) by DPD ferrous titrametric method (APHA-AWWA-WPCF, 1985). Flow volumes were calculated at selected sites using data obtained from cross-section stream measurements, and velocity measurements by a magnetic flow meter. Grab samples collected for laboratory analyses were stored in the dark on ice and received

Table 1. Walla Walla wastewater treatment plant effluent characteristics and quantity regulated by NPDES permit No. WA-002462-7.

The monthly average quantity of effluent shall not exceed 10.8 MGD

Discharge Point 001 (Discharge to Mill Creek*):

| Parameter | Monthly Average | Weekly Average |
|---|---|---|
| Biochemical oxygen demand (5-day) | 30 mg/L** 1220 lbs/day | 45 mg/L 1829 lbs/day |
| Total suspended solids | 30 mg/L** 1266 lbs/day | 45 mg/L 1899 lbs/day |
| Fecal coliform bacteria | 200/100 mL | 400/100 mL |
| pH | not outside range 6.5 - 8.5 | |
| Total residual chlorine | not to exceed 0.05 mg/L | |

Discharge Point 002 (Discharge to Blalock and Gose Irrigation Districts):

| Parameter | Monthly Average | Weekly Average |
|---|---|---|
| Biochemical oxygen demand (5-day) | 12 mg/L** 1081 lbs/day | 18 mg/L 1621 lbs/day |
| Total suspended solids | 10 mg/L** 901 lbs/day | 15 mg/L 1351 lbs/day |
| Turbidity | 10 NTU | 15 NTU |
| Total coliform | 20/100 mL | |
| pH | not outside range 6.5 - 8.5 | |

The monthly and weekly averages for $BOD_5$ and suspended solids are based upon arithmetic mean of the samples taken. The average of fecal coliform and total coliform is based upon the geometric mean of the samples taken.

*Discharge to Mill Creek (Point 001) shall only be allowed from December 1 to May 1, each year.

**The monthly average effluent concentration for $BOD_5$ and total suspended solids shall not exceed 15% of the respective monthly average influent concentrations.

Table 2. Class A (excellent) and Class B (good) freshwater quality standards (WAC 173-201-045) and characteristic uses.

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CLASS A

| | |
|---|---|
| Characteristics shall meet or exceed requirements for all or substantially all uses: | Domestic, industrial, and agricultural water supply, wildlife habitat; livestock watering; general recreation and aesthetic enjoyment; commerce and navigation; salmonid and other fish reproduction, migration, rearing, and harvesting. |

Water Quality Criteria

| | |
|---|---|
| Fecal coliform: | Geometric mean not to exceed 100 organisms/100 mLs with not more than 10 percent of samples exceeding 200 organisms/100 mLs. |
| Dissolved oxygen: | Shall exceed 8 mg/L. |
| Total dissolved gas: | Shall not exceed 110 percent saturation. |
| Temperature: | Shall not exceed 18$^{o}$C due to human activity. Increases shall not, at any time, exceed t = 28/(T+7); or where temperature exceeds 18$^{o}$C naturally, no increase greater than 0.3$^{o}$C. t = allowable temperature increase across dilution zone, and T = highest temperature outside the dilution zone. Increases from non-point sources shall not exceed 2.8$^{o}$C. |
| pH: | Shall be with the range of 6.5 to 8.5, with man-caused variation within a range of less than 0.5 unit. |
| Turbidity: | Shall not exceed 5 NTU over background when background is 50 NTU or less, or cause 10 percent increase in turbidity over background when background is greater than 50 NTU. |
| Toxic, radioactive, or deleterious materials: | Shall be below concentrations of public health significance, or which may cause acute or chronic toxic conditions to the aquatic biota, or which may adversely affect any water use. |
| Aesthetic values: | Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste. |

Table 2- continued.

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<u>CLASS B</u>

| | |
|---|---|
| Characteristics shall meet or exceed most uses: | Industrial and agricultural water supply; wildlife habitat; livestock watering; secondary contact recreation and general aesthetic enjoyment; salmonid migration, rearing, and harvesting; other fish spawning, migration, rearing, and harvesting. |

<u>Water Quality Criteria</u>

| | |
|---|---|
| Fecal coliform: | Geometric mean not to exceed 200 organisms/100 mLs with not more than 10 percent of samples exceeding 400 organisms/100 mLs. |
| Dissolved oxygen: | Shall exceed 6.5 mg/L. |
| Total dissolved gas: | Shall not exceed 110 percent saturation. |
| Temperature: | Shall not exceed 21$^{\circ}$C due to human activity. Increases shall not exceed $t = 34/(T+9)$; or where temperature exceeds 21$^{\circ}$C naturally, no increase greater than 0.3$^{\circ}$C. Increases from non-point source activities shall not exceed 2.8$^{\circ}$C and the maximum water temperature shall not exceed 21.3$^{\circ}$C. |
| pH: | Same as Class A. Shall be with the range of 6.5 to 8.5, with man-caused variation within a range of less than 0.5 unit. |
| Turbidity: | Shall not exceed 10 NTU over background when background is 50 NTU or less, or cause 20 percent increase in turbidity over background when background is greater than 50 NTU. |
| Toxic, radioactive, or deleterious materials: | Shall be below concentrations causing adverse effects for characteristic human uses or those of aquatic biota. |
| Aesthetic values: | Shall not be reduced by dissolved, floating, suspended, or submerged material not attributed to natural causes, so as to affect water use or taint the flesh of edible species. |

Table 3. Station descriptions and monitoring activiaties for a water quality survey at Mill Creek near Walla Walla, February 12-13, 1986.

| Station Number | River Mile | Station Description* | Field/ Laboratory Activities |
|---|---|---|---|
| 1 | 6.2 | Approximately 50 feet below 13th Avenue at right bank | Temperature, pH, contivity, dissolved oxygen/fecal coliform, COD, nutrients (5), turbidity, chloride, total suspended solids |
| 2 | 5.5 | Approximately 500 feet above the Walla Walla WTP outfall, at left-center | Discharge, temperature, pH, conductivity, D.O./ same as Station 1 + BOD and solids (4) |
| Walla Walla WTP Effluent | 5.4 | Walla Walla WTP outfall, left bank composite and grab samples | Same as Station 2 + TRC |
| 3 | 4.8 | Approximately 25 feet above the Gose Street bridge crossing, midstream | Temperature, pH, conductivity, dissolved oxygen/Same as above. |
| 4 | 4.4 | Approximately 10 feet below Hussey Street bridge, mid-stream | Same as Station 2. |
| 5 | 2.7 | Approximately 25 feet above the Wallula Avenue bridge crossing, mid-stream | Same as Station 2. |
| 6 | 1.7 | Beneath the Last Chance Road bridge, mid-stream | Same as Station 1. |
| 7.0 | 0.4 | Approximately 50 feet below the Mission Road bridge, mid-stream | Same as Station 4. |

*Left or right bank determined as observer faces downstream.

Table 4. Sample results from the February 12-13, 1986, survey of Mill Creek in the vicinity of Walla Walla WTP (all values are mg/L unless otherwise indicated).

| | | | | | Field Data | | | | | | Laboratory Data | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| River Mile | Station Number | Date | Time | Discharge (cfs) | Temperature (°C) | pH (S.U.) | Spec. Cond. (umhos/cm) | Dissolved Oxygen | Dissolved Oxygen % Sat. | Total Residual Chlorine | Fecal Coliform (#/100 mL) | $BOD_5$ | COD | $NH_3$-N | Un-ionized $NH_3$-N | $NO_3$-N | $NO_2$-N | Total Inorg. Nitrogen | O-$PO_4$-P | Total P | pH (S.U.) | Spec. Cond. (umhos/cm) | $Cl^-$ | Turbidity (NTU) | Total Solids | TNVS | TSS | TNVSS |
| 6.2 | 1 | 2/12 | | 95 | 3.4 | 7.5 | 85 | 13.2 | 99.0 | | 8 | | 11 | 0.02 | <0.001 | 0.74 | <0.01 | 0.76 | 0.04 | 0.06 | 7.8 | 72 | 2.8 | 4 | | | 10 | |
| | | 2/13 | 1115 | 89 | 1.2 | 7.8 | 80 | 14.0 | 99.0 | | 15 | | 7 | 0.01 | <0.001 | 0.74 | <0.01 | 0.75 | 0.04 | 0.04 | 7.7 | 72 | 1.2 | | | | 3 | |
| 5.5 | 2 | 2/12 | | 95 | 2.8 | 7.6 | 85 | 14.0 | 103.3 | | 5 | | 11 | 0.01 | <0.001 | 0.78 | <0.01 | 0.79 | 0.04 | 0.04 | 8.1 | 68 | 1.2 | 4 | | | 7 | |
| | | 2/12 | 1720 | | 3.7 | | | 12.9 | 97.4 | | | | | | | | | | | | | | | | | | | |
| | | 2/13 | 1045 | 89 | 1.0 | 7.9 | 85 | 14.5 | 101.9 | | 20 | <4 | 11 | 0.01 | <0.001 | 0.79 | <0.01 | 0.80 | 0.03 | 0.04 | 8.1 | 77 | 1.4 | | 86 | 57 | 4 | 1 |
| 5.4 | ** | 2/12 | | 12 | 9.5 | 7.2 | 290 | 9.2 | 80.3 | 0.2 | 1 | 19 | 71 | 3.80 | 0.011 | 9.3 | 0.44 | 13.54 | 2.4 | 3.1 | 7.2 | 260 | 20 | 9 | 340 | 150 | 21 | 5 |
| | | 2/13 | | 11 | 8.4 | 7.2 | 280 | | | <0.1 | 1 | | 60 | 2.80 | 0.007 | 8.5 | 0.36 | 11.66 | 2.1 | 2.7 | 7.0 | 251 | 22 | 7 | | | 21 | |
| 4.8 | 3 | 2/12 | 1050 | 107 | 3.3 | 7.7 | 115 | 13.4 | 100.1 | <0.1 | 2 | | 15 | 0.46 | 0.002 | 2.10 | 0.06 | 2.62 | 0.32 | 0.39 | 7.7 | 98 | 3.7 | 4 | | | 11 | |
| | | 2/12 | 1710 | | 4.4 | | | 12.6 | 96.9 | | | | | | | | | | | | | | | | | | | |
| | | 2/13 | 1015 | 100 | 2.2 | 7.3 | 115 | 13.4 | 97.3 | <0.1 | 35 | <4 | 11 | 0.34 | <0.001 | -- | -- | -- | 0.34 | 0.41 | 7.7 | 105 | 4.2 | | 110 | 65 | 7 | 1 |
| 4.4 | 4 | 2/12 | 1035 | 107 | 3.0 | 7.9 | 108 | 13.5 | 100.1 | | 16 | | 11 | 0.27 | 0.002 | 1.60 | 0.04 | 1.91 | 0.24 | 0.29 | 7.8 | 91 | 3.4 | 4 | | | 7 | |
| | | 2/12 | 1700 | | 4.2 | | | 12.7 | 97.2 | | | | | | | | | | | | | | | | | | | |
| | | 2/13 | 0950 | 100 | 1.7 | 7.7 | 110 | 13.7 | 98.1 | | 31 | | 11 | 0.28 | 0.001 | 1.80 | 0.04 | 2.12 | 0.28 | 0.35 | 7.7 | 99 | 3.6 | | 100 | 63 | 6 | 2 |
| 2.7 | 5 | 2/12 | 1000 | 118 | 3.1 | 7.6 | 130 | 13.1 | 97.5 | | 17 | | 11 | 0.20 | <0.001 | 2.10 | 0.03 | 2.33 | 0.23 | 0.28 | 7.5 | 112 | 6.3 | 4 | | | 5 | |
| | | 2/12 | 1650 | | 4.4 | | | 12.3 | 94.6 | | | | | | | | | | | | | | | | | | | |
| | | 2/13 | 0940 | 112 | 1.9 | 7.5 | 130 | 13.4 | 96.5 | | 16 | | 15 | 0.22 | <0.001 | 1.9 | 0.03 | 2.15 | 0.27 | 0.28 | 7.4 | 116 | 6.9 | | | | 3 | |
| 1.7 | 6 | 2/12 | 0945 | 118 | 3.0 | 7.7 | | 13.3 | 98.7 | | 8 | | 7 | 0.19 | 0.001 | 1.80 | 0.03 | 2.02 | 0.22 | 0.26 | 7.5 | 120 | 6.1 | 3 | | | 6 | |
| | | 2/12 | 1630 | | 4.4 | | | 12.3 | 94.6 | | | | | | | | | | | | | | | | | | | |
| | | 2/13 | 0920 | 112 | 1.6 | 7.5 | 135 | 13.5 | 96.4 | | 19 | | 11 | 0.21 | <0.001 | 1.80 | 0.03 | 2.04 | 0.26 | 0.27 | 7.5 | 118 | 6.8 | | | | 8 | |
| 0.4 | 7 | 2/12 | 0915 | 118 | 3.0 | 7.5 | 135 | | | | 21 | | 7 | 0.20 | <0.001 | 2.00 | 0.03 | 2.23 | 0.20 | 0.25 | 7.6 | 115 | 6.8 | 3 | | | 10 | |
| | | 2/12 | 1615 | | 4.4 | | | 12.5 | 96.2 | | | | | | | | | | | | | | | | | | | |
| | | 2/13 | 0855 | 112 | 2.0 | 7.4 | 140 | 13.3 | 96.1 | | 20 | | 15 | 0.20 | <0.001 | -- | -- | -- | | 0.26 | 7.6 | 125 | 7.4 | | 130 | 78 | 4 | 2 |

**Walla Walla WTP (data from Heffner [1986] Class II inspection).

Table 5. Comparison of nutrient concentrations from four southeastern Washington rivers. Nutrient concentrations are mean $\pm$ 1 standard deviation in mg/L, for the months of October through April (Ecology, 1986). Mill Creek data from the February 1986 survey included for comparison.

| Station | Ecology Number | Sampling Dates | Number of Samples | $NO_3$-N | $NO_2$-N | $NO_2$+$NO_3$-N | $NH_3$-N | O-$PO_4$-P | Total P |
|---|---|---|---|---|---|---|---|---|---|
| Mill Creek at r.m. 10 at Tausick Way | 32C110 | 1973-74 | 14 | 0.5 $\pm$ 0.3 | 0.01 | -- | 0.09 $\pm$ 0.04 | 0.04 $\pm$ 0.01 | 0.1 $\pm$ 0.06 |
| Tucannon River at r.m. 23 at Powers | 35B060 | 1973-86 | 34 - 75 | 0.4 $\pm$ 0.2 | 0.01 | 0.5 $\pm$ 0.4 | 0.1 $\pm$ 0.1 | 0.07 $\pm$ 0.05 | 0.2 $\pm$ 0.4 |
| Touchet River at r.m. 0.5 at Touchet | 32B070 | 1971-86 | 96 - 100 | 1.0 $\pm$ 0.5 | 0.02 $\pm$ 0.01 | -- | 0.2 $\pm$ 0.2 | 0.07 $\pm$ 0.07 | 0.3 $\pm$ 0.6 |
| Palouse River at r.m. 94.8 at Colfax | 34A110 | 1970-75 | 26 - 33 | -- | -- | 1.6 $\pm$ 1.3 | 0.3 $\pm$ 0.5 | 0.08 $\pm$ 0.06 | 0.2 $\pm$ 0.2 |
| Mill Cr. above the Walla Walla WTP - 2/86 | | 1986 | 4 | 0.76 $\pm$ 0.03 | <0.01 | -- | 0.012 $\pm$ 0.005 | 0.038 $\pm$ 0.005 | 0.04 $\pm$ 0.01 |

via air freight by the Ecology/USEPA Manchester Environmental Laboratory within 24 hours. All analyses were performed using approved procedures (USEPA, 1983; APHA-AWWA-WPCF, 1985). Walla Walla WTP flow and water quality data were obtained from Heffner's (1986) Class II survey. There is a difference between the nutrient analysis procedures used in 1981 (Singleton and Joy, 1982) and those used in the current survey. In the former survey, all nutrient samples were unfiltered and acidified. In the latter, samples for $O-PO_4$ were filtered and unacidified, and $NO_2$ and $NO_3$ were unacidified.

## RESULTS

### Upstream of Walla Walla WTP

Water quality at Stations 1 and 2 above the WTP, met all Class A criteria (Tables 2 and 4). Transverse groins improved D.O. between Station 1 and Station 2. No changes in other water quality parameters were observed between Station 1 and Station 2 (Table 4).

Nitrate concentrations were similar to other eastern Washington streams during winter months (Table 5).

Nitrogen and phosphorus concentrations were higher than eutrophication potential threshold values (Table 6).

Table 6. Eutrophication potential as a function of nutrient concentrations* (from Mills, et al., 1985). Included are selected Mill Creek survey results.

| Nutrient Concentration P (mg-P/L) | Nutrient Concentration N (mg-N/L) | Growth Potential Dry Algal Cells (mg/L) | Significance |
|---|---|---|---|
| 0.013 | 0.092 | 1.45 | Problem threshold |
| 0.13 | 0.92 | 14.5 | Problem likely to exist |
| 1.3 | 9.2 | 145.0 | Severe problems possible |
| Survey Data | | | |
| 0.04 | 0.78 | -- | Stations 1 and 2 average |

*Both nitrogen and phosphorus must be present in the amounts shown for the resultant growth to occur.

Temperatures, light, and residence time probably limited utilization of nutrients by periphyton and algal species at the time of the survey. We observed heavy periphyton growth at all stations. The relatively wide fluctuation in D.O. concentrations recorded at Station 2

The polishing filter problem continued to plague plant operation for a month or more after the survey (Heffner, 1986). The chlorine residual problem was corrected during the inspection by manual operation.

Despite these problems, effluent concentrations of BOD, TSS, and fecal coliform, and pH levels were within NPDES permit limits (Tables 1 and 4). The BOD and TSS concentrations were slightly higher than recorded during the 1981 survey (Table 8). Residual chlorine and fecal coliform levels in 1986 were lower than found 1981. Ammonia, total inorganic nitrogen (TIN), and phosphorus effluent concentrations were similar during both surveys.

One additional discharge was noted at the WTP site. Onion wastewater was detected flowing from a three-inch pipe just upstream of the outfall. The pipe is evidently connected through a valve to the industrial portion of the WTP leased by the city to a private company. The pipe is used to drain a portion of the industrial process line after the processing season has ended. Wastewater collected from the line was flowing because the valve had not been closed after last season's draining. The wastewater discharge was less than 0.1 cfs and had the following characteristics:

pH = 4.9
specific conductivity = 230 umhos/cm
temperature = 16$^{\circ}$C

Once notified, plant personnel were quick to close the valve. ERO staff recommended the pipe be routed away from the creek and into the WTP. On their next visit, ERO staff should check to see that their recommendation was followed.

## Mill Creek Below the Walla Walla WTP

Mixing of effluent and creek water was complete by Station 4, one mile below the outfall. Mass balance and transverse mixing analyses suggest that samples collected 0.6 mile below the WTP at Station 3 were biased with effluent. Water quality at Station 4 met Class B criteria. In fact, pH, D.O., turbidity, temperature, and coliform levels all met Class A criteria. Ammonia and chlorine toxicity problems were not apparent. The theoretical instream un-ionized $NH_3$-N levels were far below the four-day average criteria recommended by USEPA (1986). The criteria are tied to instream pH and temperature conditions and have been calculated for each particular downstream site in Table 9.

Although 0.2 mg/L was detected in the effluent, chlorine residuals were not detected at Stations 3 or 4 (Table 4). Theoretically, total mixed concentrations could have been from 0.011 to 0.022 mg/L at various times when the automatic chlorinator-dechlorinator unit was malfunctioning. However, aeration of the water downstream of the plant probably volatilized the chlorine. Levels were probably below the recommended 0.019 mg/L acute and 0.01 chronic criteria (USEPA, 1986). As noted by Heffner (1986), proper operation of chlorine monitoring could have been induced by periphytic and general benthic activity (Figure 2).

Flow was near the February one-in-five-year low monthly flow level of 86 cfs (Table 7).

Table 7. Monthly low flow recurrence interval for USGS station 14015002, Mill Creek at river mile 10, covering 1966 to 1980 discharge records.

| | Stream flow (cfs) Recurrence Interval - low monthly flow | | | |
|---|---|---|---|---|
| Month | 2-year | 5-year | 10-year | 20-year |
| January | 185.0 | 90.3 | 57.7 | 38.3 |
| February | 170.8 | 85.9 | 49.4 | 28.0 |
| March | 163.4 | 98.4 | 72.4 | 55.0 |
| April | 144.3 | 78.5 | 55.1 | 40.4 |
| May | 71.5 | 14.7 | 4.9 | 1.7 |
| June | 10.4 | 1.9 | 0.7 | 0.3 |
| July | 1.5 | 0.4 | 0.2 | 0.1 |
| August | 1.3 | 0.6 | 0.4 | 0.2 |
| September | 0.7 | 0.2 | 0.1 | 0.0 |
| October | 1.1 | 0.2 | 0.1 | 0.0 |
| November | 11.7 | 2.4 | 1.0 | 0.5 |
| December | 86.8 | 33.3 | 19.1 | 11.7 |

Compared to 1981, no major changes in water quality were observed. Nitrate concentrations were double the 1981 value (Table 8). However, historically there has been high variability in $NO_3$-N concentrations on Mill Creek recorded in 1973-75 above WTP at r.m. 10 (Ecology, 1986).

Walla Walla WTP Effluent

The WTP was operating at 11 to 12 cfs (7 - 8 MGD). The 7:1 to 8:1 dilution ratio in the creek is far below the 100:1 dilution ratio recommended by facilities design policy (Ecology, 1985). However, the ERO recognizes this inadequacy.

The plant was not operating efficiently. Heffner (1986) listed the following problems during his Class II inspection:

- Poor polishing filter performance resulted in lower than anticipated TSS and BOD removal rates--they were less than monthly average NPDES limits.
- The automatic chlorination-dechlorination monitoring system malfunctioned, resulting in higher-than-permitted chlorine residual concentrations.

Figure 2.

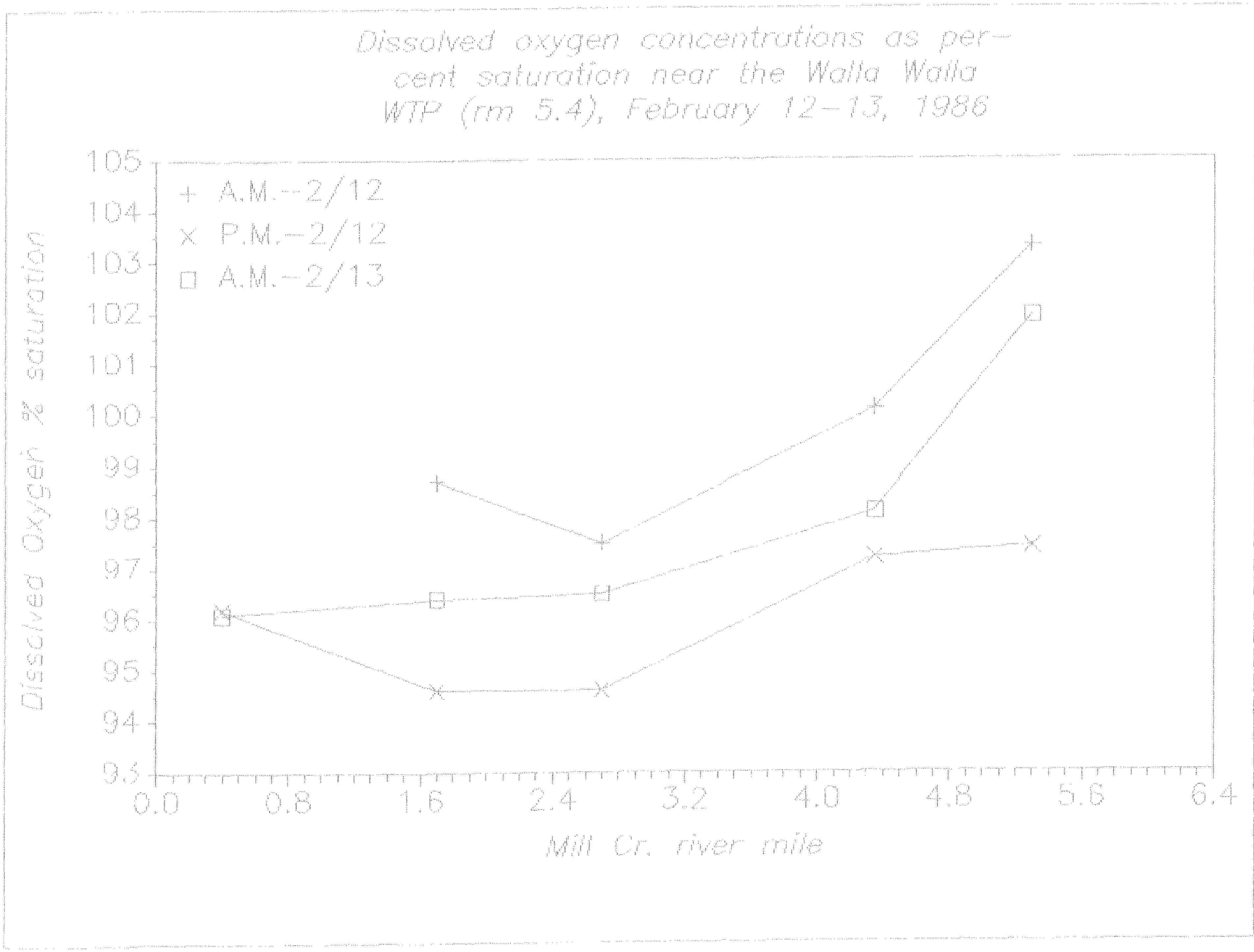

Dissolved oxygen concentrations as per-
cent saturation near the Walla Walla
WTP (rm 5.4), February 12–13, 1986
Dissolved Oxygen % saturation
105
104
103
102
101
100
99
98
97
96
95
94
93
0.0
0.8
1.6
2.4
3.2
4.0
4.8
5.6
6.4
Mill Cr. river mile
+ A.M.–2/12
× P.M.–2/12
□ A.M.–2/13

Table 8. Results from the 1981 Mill Creek receiving water survey performed by Singleton and Joy (1982) on February 3 and 4. All values mg/L unless otherwise indicated.

| | | Station Number and Description | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameter | Date | 1 Tausick Road | 2 Division Street | Point Source | 3 Park street | 4 Colville Street | 5 4th Ave. Bridge | 6 13th Ave. Bridge | Point Source | 7 Upstream of STP | STP Effluent | 8 Gose Street Bridge | 9 Hussy Road Bridge | 10 Highway 410 | 11 Mission Road |
| River Mile | | 10.0 | 8.1 | 7.8 | 7.7 | 7.4 | 6.9 | 6.3 | 6.2 | 5.6 | 5.4 | 4.8 | 4.35 | 2.7 | 0.4 |
| Flow (cfs) | 2/3 | 61 | -- | -- | -- | -- | -- | -- | -- | | 10.2 | | | | |
| | 2/4 | 57 | -- | -- | -- | -- | -- | -- | -- | 60.7 | | 73 | 69 | -- | 73 |
| Temperature (°C) | 2/3 | 2.0 | 2.0 | 19.4 | 2.0 | 3.8 | 3.0 | 3.0 | | 2.0 | 10.4 | 4.0 | 3.0 | 3.0 | 3.0 |
| | 2/4 | 2.0 | 2.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 4.8 | 2.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| pH (S.U.) | 2/3 | 7.9 | 7.7 | 8.4 | 7.7 | 7.8 | 7.9 | 8.0 | | 7.9 | 7.5* | 8.0 | 8.0 | 7.7 | 7.8 |
| | 2/4 | 8.1 | 8.1 | | 7.9 | 8.1 | 8.1 | 8.3 | 7.9 | 8.0 | | 8.0 | 8.0 | 7.8 | 7.9 |
| Dissolved Oxygen | 2/3 | 11.8 | 12.1 | | 12.1 | 12.2 | 12.4 | 12.7 | | 13.3 | 9.1 | 12.1 | 12.4 | 11.6 | 11.4 |
| | 2/4 | 12.2 | 12.4 | | 12.6 | 12.7 | 12.8 | 13.3 | -- | 13.3 | | 12.5 | 12.5 | 11.9 | 11.7 |
| % Dissolved Oxygen Sat. | 2/3 | 88 | 90 | | 90 | 96 | 95 | 97 | | 99 | 81* | 95 | 95 | 89 | 87 |
| | 2/4 | 91 | 93 | | 97 | 97 | 98 | 102 | | 101 | | 97 | 97 | 92 | 91 |
| Conductivity (umhos/cm) | | | | | | | | | | | | | | | |
| Field Data | 2/3 | 75 | 79 | 215 | 85 | 89 | 86 | 83 | | 84 | | 120 | 111 | 150 | 172 |
| Lab Data | 2/3 | 73 | 70 | 209 | 76 | 79 | 78 | 80 | | 85 | | 110 | 112 | 124 | 165 |
| Field Data | 2/4 | 80 | 78 | | 85 | 87 | 85 | 90 | 83 | 90 | | 120 | 115 | 155 | 175 |
| Lab Data | 2/4 | 73 | 71 | | 78 | 78 | 79 | 79 | 79 | 91* | 265* | 115 | 125* | 144 | 164 |
| Tot. Residual Chlorine | 2/3 | | | | | | | | | | 0.45 | 0.05 | N.D. | | |
| | 2/4 | | | | | | | | | | | 0.05 | N.D. | | |
| Turbidity (NTU) | 2/3 | 4 | | | | 5 | | | | 4 | 10* | | 4 | | 2 |
| | 2/4 | 4 | | | | 4 | | | | 6* | | | 5* | | 3 |
| COD | 2/3 | 9 | | | | 4 | | | | 9 | 55* | | 13 | | 13 |
| | 2/4 | 9 | | | | 9 | | | | 13* | | | 26* | | 17 |
| $BOD_5$ | 2/3 | 1.2 | | | | 4.9 | | | | 1.7 | 11* | | 1.9 | | 1.6 |
| | 2/4 | 1.7 | | | | 1.6 | | | | 2.3* | | | 3.9* | | 1.2 |
| $BOD_{12}$ | 2/3 | 1.9 | | | | 7.5 | | | | 2.8 | | | 4.5 | | |
| | 2/4 | 2.3 | | | | 2.6 | | | | 3.3* | | | 8.7* | | |
| $BOD_{15}$ | 2/3 | 1.9 | | | | 7.8 | | | | 2.9 | | | 5.4 | | |
| | 2/4 | 2.4 | | | | 3.5 | | | | 3.3* | | | 9.3* | | |
| $BOD_{20}$ | 2/3 | 2.4 | | | | 8.1 | | | | 3.4 | | | 6.2 | | |
| | 2/4 | 2.6 | | | | 4.5 | | | | 4.0* | | | 10.0* | | |
| Fecal Coliform (org/100 ml) | 2/3 | 6** | 9** | <2** | 20** | 9** | 17** | 5** | | 10** | 540 | 29** | 140 | 9** | 7** |
| | 2/4 | <2** | 4** | | <2** | 6** | 7** | 10** | 5** | 8** | 260 | 68 | 6** | 8** | 2** |
| $NO_3$-N | 2/3 | 0.34 | 0.34 | <0.01 | 0.38 | 0.41 | 0.42 | 0.42 | | 0.45 | 5.35* | 1.40 | 1.10 | 1.60 | 1.90 |
| | 2/4 | 0.39 | 0.35 | | 0.38 | 0.40 | 0.40 | 0.43 | 0.38 | 0.47* | | 1.30 | 1.10* | 1.70 | 2.20 |
| $NO_2$-N | 2/3 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | | <0.01 | <0.05* | 0.03 | 0.02 | 0.02 | 0.03 |
| | 2/4 | <0.01 | <0.01 | | <0.01 | <0.01 | <0.01 | <0.01 | 0.02 | <0.01* | | 0.02 | 0.03* | 0.03 | 0.03 |
| $NH_3$-N | 2/3 | <0.01 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | | <0.01 | 3.6* | 0.60 | 0.21 | 0.20 | 0.13 |
| | 2/4 | <0.01 | <0.01 | | <0.01 | <0.01 | <0.01 | <0.01 | 0.02 | <0.01* | | 0.37 | 0.44* | 0.28 | 0.18 |
| Un-ionized $NH_3$-N | 2/3 | | | | | | | | | | 0.022* | 0.007 | 0.002 | 0.001 | 0.001 |
| | 2/4 | | | | | | | | <0.001 | | | 0.004 | 0.005* | 0.002 | 0.002 |
| O-$PO_4$-P | 2/3 | 0.03 | 0.03 | 0.01 | 0.03 | 0.03 | 0.03 | 0.03 | | 0.03 | 2.45* | 0.42 | 0.32 | 0.31 | 0.32 |
| | 2/4 | 0.04 | 0.03 | | 0.03 | 0.03 | 0.04 | 0.04 | 0.09 | 0.04* | | 0.35 | 0.39* | 0.35 | 0.35 |
| T-$PO_4$-P | 2/3 | 0.05 | 0.06 | 0.03 | 0.05 | 0.06 | 0.03 | 0.05 | | 0.05 | 3.10* | 0.56 | 0.40 | 0.37 | 0.36 |
| | 2/4 | 0.06 | 0.05 | | 0.06 | 0.05 | 0.06 | 0.06 | 0.09 | 0.06* | | 0.43 | 0.50* | 0.41 | 0.40 |
| Total Solids | 2/3 | 85 | | | | 89 | | | | 88 | 218* | | 110 | | 140 |
| | 2/4 | 87 | | | | 94 | | | | 95* | | | 120* | | 150 |
| T. Non-Vol. Solids | 2/3 | 58 | | | | 75 | | | | 71 | 140* | | 86 | | 98 |
| | 2/4 | 59 | | | | 69 | | | | 75* | | | 82* | | 100 |
| Total Suspended Solids | 2/3 | 3 | | | | 4 | | | | 2 | 11* | | 2 | | 5 |
| | 2/4 | 4 | | | | 1 | | | | 2* | | | 3* | | 2 |
| T. Non-Vol. Susp. Solids | 2/3 | <1 | | | | <1 | | | | <1 | 2* | | <1 | | <1 |
| | 2/4 | <1 | | | | 1 | | | | <1* | | | <1* | | <1 |
| Chlorides | 2/3 | 1.5 | <1.0 | 1.5 | 1.5 | 1.5 | <1.0 | 2.3 | | 2.3 | | 3.1 | 3.1 | 6.9 | 9.2 |
| | 2/4 | 2.0 | <1.0 | | 2.0 | 2.0 | 1.0 | 2.0 | 1.5 | 2.0* | | 5.0 | 4.0* | 8.0 | 9.0 |
| T. Recoverable Copper | 2/3 | <0.01 | | | | | | | | <0.01 | | | <0.01 | | <0.01 |
| | 2/4 | <0.01 | | | | | | | | <0.01* | | | <0.01* | | <0.01 |
| T. Recoverable Zinc | 2/3 | <0.01 | | | | | | | | <0.01 | | | <0.01 | | <0.01 |
| | 2/4 | 0.03 | | | | | | | | 0.02* | | | 0.02* | | <0.01 |
| T. Recoverable Iron | 2/3 | 0.38 | | | | | | | | 0.37 | | | 0.19 | | 0.19 |
| | 2/4 | 0.40 | | | | | | | | 0.40* | | | 0.33* | | 0.22 |
| T. Recoverable Nickel | 2/3 | 0.05 | | | | | | | | <0.03 | | | <0.03 | | <0.03 |
| | 2/4 | <0.03 | | | | | | | | <0.03* | | | 0.05* | | 0.05 |
| T. Recoverable Chromium | 2/3 | <0.02 | | | | | | | | <0.02 | | | <0.02 | | <0.02 |
| | 2/4 | <0.02 | | | | | | | | <0.02* | | | <0.02* | | <0.02 |
| T. Recoverable Cadmium | 2/3 | <0.01 | | | | | | | | <0.01 | | | <0.01 | | <0.01 |
| | 2/4 | <0.01 | | | | | | | | <0.01* | | | <0.01* | | <0.01 |
| T. Recoverable Lead | 2/3 | <0.07 | | | | | | | | <0.07 | | | <0.07 | | <0.07 |
| | 2/4 | <0.07 | | | | | | | | <0.07* | | | <0.07* | | <0.07 |
| T. Recoverable Manganese | 2/3 | <0.02 | | | | | | | | <0.02 | | | <0.02 | | <0.02 |
| | 2/4 | <0.02 | | | | | | | | <0.02* | | | <0.02* | | <0.02 |

*24-hour composite.
**Estimated counts.

Table 9. Un-ionized ammonia concentrations and appropriate (4-day average chronic) aquatic toxicity criterion calculated for the 1986 Mill Creek receiving water survey.

| Station Number | Temp. ($^{o}C$) | pH (S.U.) | $NH_3$-N (mg/L) | Un-ionized $NH_3$-N (mg/L) | 4-day Average Toxicity Criterion (as un-ionized $NH_3$-N) |
|---|---|---|---|---|---|
| 1 | 3.4 | 7.5 | 0.02 | <0.001 | 0.007 |
| | 1.2 | 7.8 | 0.01 | <0.001 | 0.010 |
| 2 | 2.8 | 7.6 | 0.01 | <0.001 | 0.008 |
| | 3.7 | | | | |
| | 1.0 | 7.9 | 0.01 | <0.001 | 0.010 |
| Walla | 9.5 | 7.2 | 3.80 | 0.011 | 0.006 |
| Walla | 8.4 | 7.2 | 2.80 | 0.007 | 0.005 |
| WTP | | | | | |
| 3 | 3.3 | 7.7 | 0.46 | 0.002 | 0.011 |
| | 4.4 | | | | |
| | 2.2 | 7.3 | 0.34 | <0.001 | 0.005 |
| 4 | 3.0 | 7.9 | 0.27 | 0.002 | 0.012 |
| | 4.2 | | | | |
| | 1.7 | 7.7 | 0.28 | 0.001 | 0.010 |
| 5 | 3.1 | 7.6 | 0.20 | <0.001 | 0.009 |
| | 4.4 | | | | |
| | 1.9 | 7.5 | 0.22 | <0.001 | 0.006 |
| 6 | 3.0 | 7.7 | 0.19 | 0.001 | 0.011 |
| | 4.4 | | | | |
| | 1.6 | 7.5 | 0.21 | <0.001 | 0.006 |
| 7 | 3.0 | 7.5 | 0.20 | <0.001 | 0.007 |
| | 4.4 | | | | |
| | 2.0 | 7.4 | 0.20 | <0.001 | 0.005 |

equipment should be assured. The TRC concentrations observed during the 1986 survey were a great improvement over the 1981 concentrations (Tables 4 and 8). This occurred despite the 1986 equipment problems.

There was a slight loss of D.O. below the plant relative to upstream D.O. saturation levels (Figure 2). Model simulations suggest some of the loss could be attributed to effluent BOD and NOD exertion, but that natural reaeration processes should have brought D.O. levels back more quickly than was observed (Figure 3). The process responsible for the differences between field data and simulation results could be: (1) influences of periphyton respiration and production, or (2) additional point or non-point sources of wastes entering the river between r.m. 4.4 and 0.4 (Figure 1).

A shallow, well-aerated creek such as Mill Creek is an ideal habitat for a very productive periphyton community. However, the current Mill Creek model is inadequate to simulate periphyton effects (Singleton and Joy, 1982).

A waste source between r.m. 0.4 and 4.4 is also a possibility. There was an 11 cfs gain between r.m. 4.4 and 2.7 (Table 4). As noted in the 1981 survey, nitrates, chlorides, and specific conductivity increased between the two stations. Maps of the area do not show any tributaries entering that reach. In addition the, water master for the region does not know of any irrigation returns in the area (Personal conversation with H. Hansen, Ecology water master, Dec. 1986). Back-calculating from 1986 instream loads, the waste source would need to have the following characteristics:

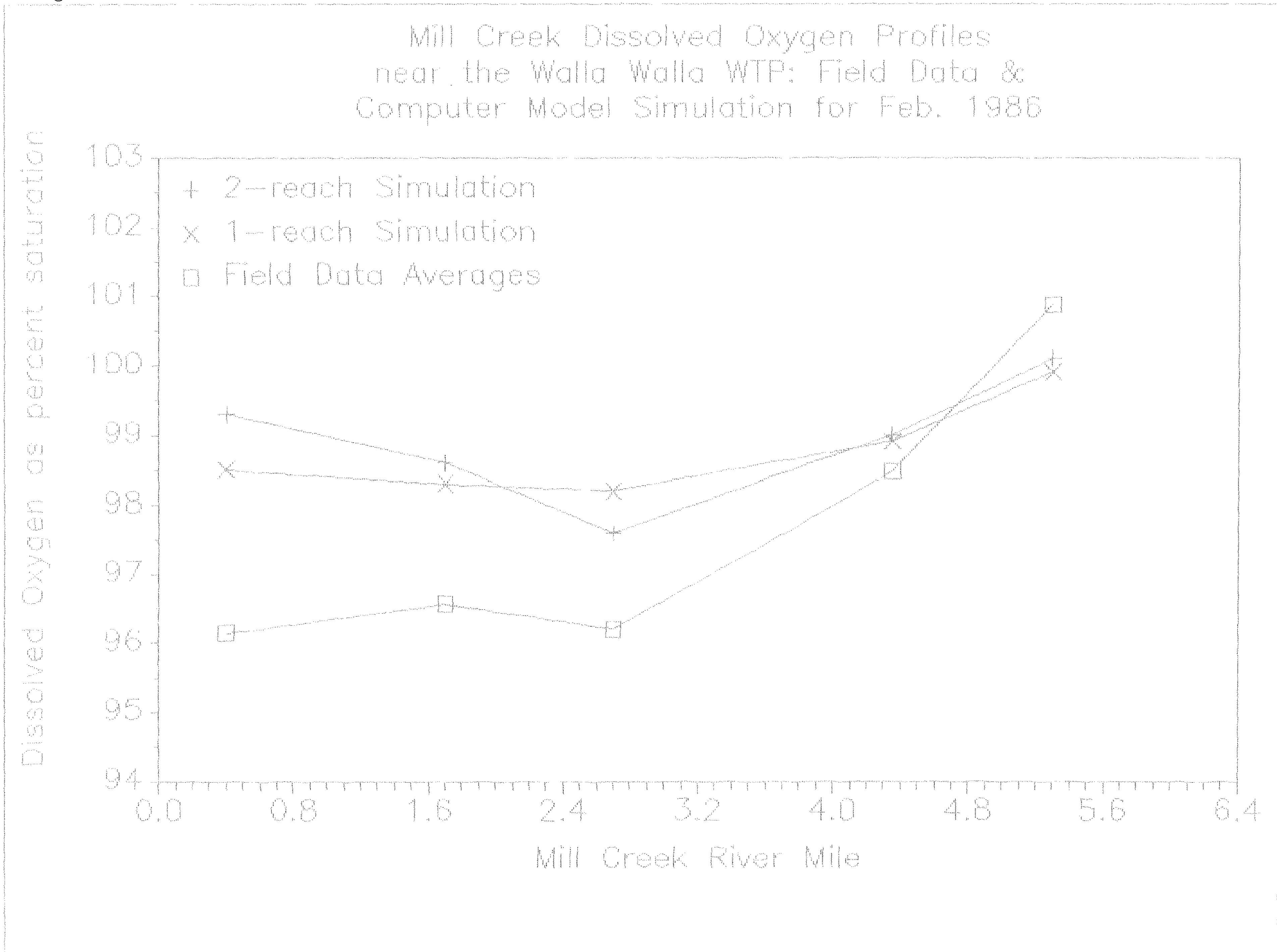
11 cfs: flow
325 - 345 umhos/cm: specific conductivity
31 - 37 mg/L: chloride

The source(s) evidently are also high in $NO_3$, but low in coliform, phosphorus, and carbonaceous materials. Such a source(s) would not be expected to exert a large demand on instream oxygen resources, so the periphyton explanation may be slightly more reasonable.

The 1986 D.O. profile below the WTP was an improvement over the 1981 profile (Figure 4). The downstream D.O. depression was shallower and shorter in 1986. The data are not available to explain the change, but it may be related to reduced periphyton activity as a result of: (1) elimination of wastewater from the creek in October and November, (2) differences in light intensity during the two surveys, or (3) periphyton habitat destruction during the U.S. Army Corps of Engineers bank rip-rap construction during the summer of 1985 from r.m. 4.4 to 5.8.

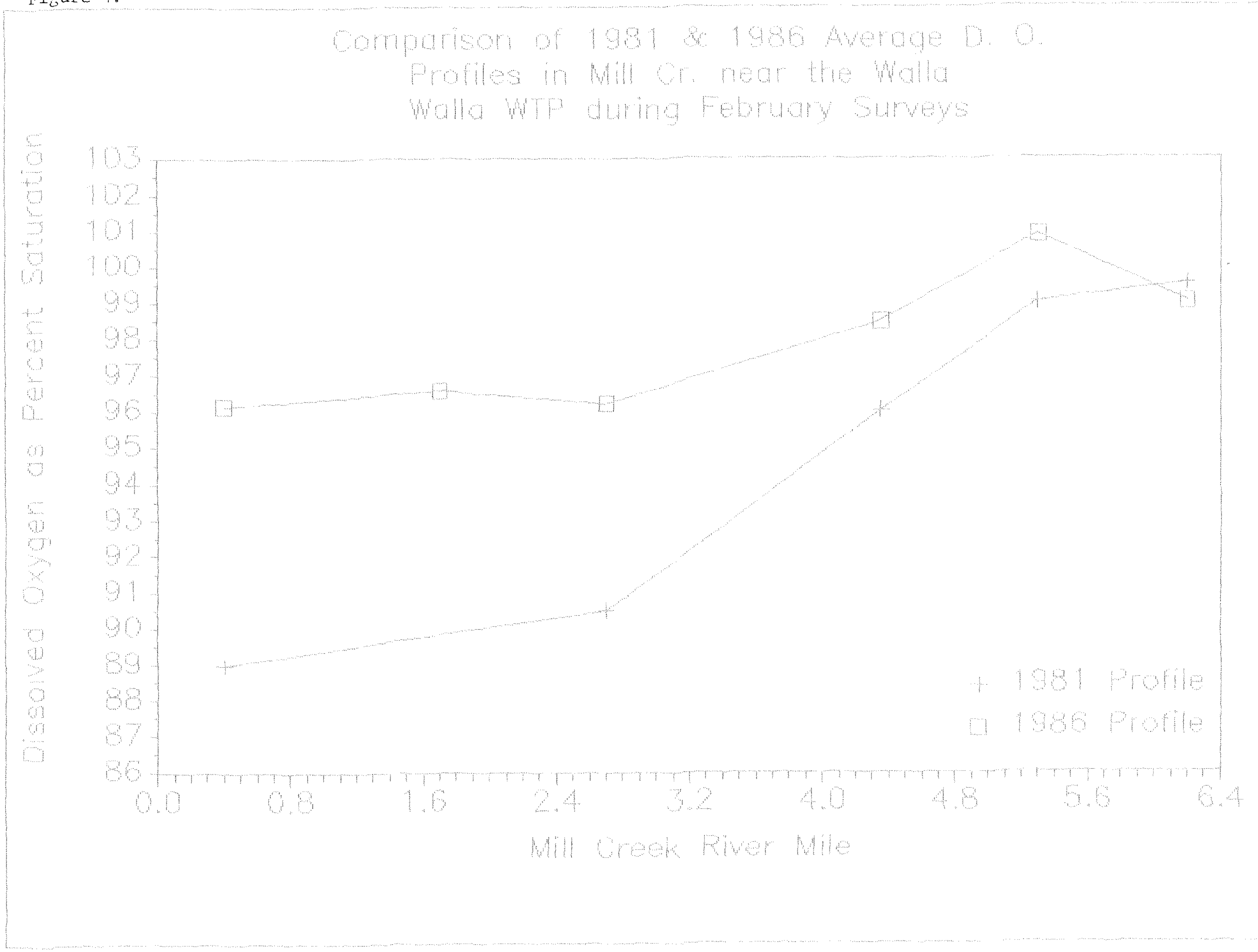
Oxygen demand components of the WTP effluent were similar during both surveys. The characteristics of oxygen demand in other waste sources are unknown.

Figure 3.



Mill Creek Dissolved Oxygen Profiles
near the Walla Walla WTP: Field Data &
Computer Model Simulation for Feb. 1986
2-reach Simulation
1-reach Simulation
Field Data Averages
Dissolved Oxygen as percent saturation
103
102
101
100
99
98
97
96
95
94
0.0
0.8
1.6
2.4
3.2
4.0
4.8
5.6
6.4
Mill Creek River Mile

Figure 4.


Comparison of 1981 & 1986 Average D. O.
Profiles in Mill Cr. near the Walla
Walla WTP during February Surveys
Dissolved Oxygen as Percent Saturation
103
102
101
100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
0.0
0.8
1.6
2.4
3.2
4.0
4.8
5.6
6.4
Mill Creek River Mile
1981 Profile
1986 Profile

The wastewater elevated phosphorus and nitrogen levels in the creek (Table 4, Figure 5). These loads and instream concentrations were reduced somewhat by the benthic community. For example, in the first mile below the outfall, 20 pounds (10 percent) of the phosphorus load and 50 pounds of TIN were used (Figure 5). Additional gains of nitrate downstream of the WTP and instream concentrations of phosphorus and ammonia six and eight times their respective Station 2 (control) levels exceed the "problem likely to exist" eutrophication potentials in Table 6. As suggested, the periphyton community could possibly utilize some of these nutrients under better light and temperature conditions. However, most nutrients are probably exported to the Walla Walla and Lower Columbia Rivers. This will be discussed later in the Total Maximum Daily Load Evaluation section.

Nutrient levels downstream of the WTP in 1986 were similar to those observed in 1981 (Tables 4 and 8).

In summary, although the Walla Walla WTP was not operating properly, the effluent was of high enough quality to have minimum effect on Mill Creek water quality. Low residual chlorine, ammonia, and BOD concentrations maintained Class A and B water quality criteria and did not endanger resident fish populations.

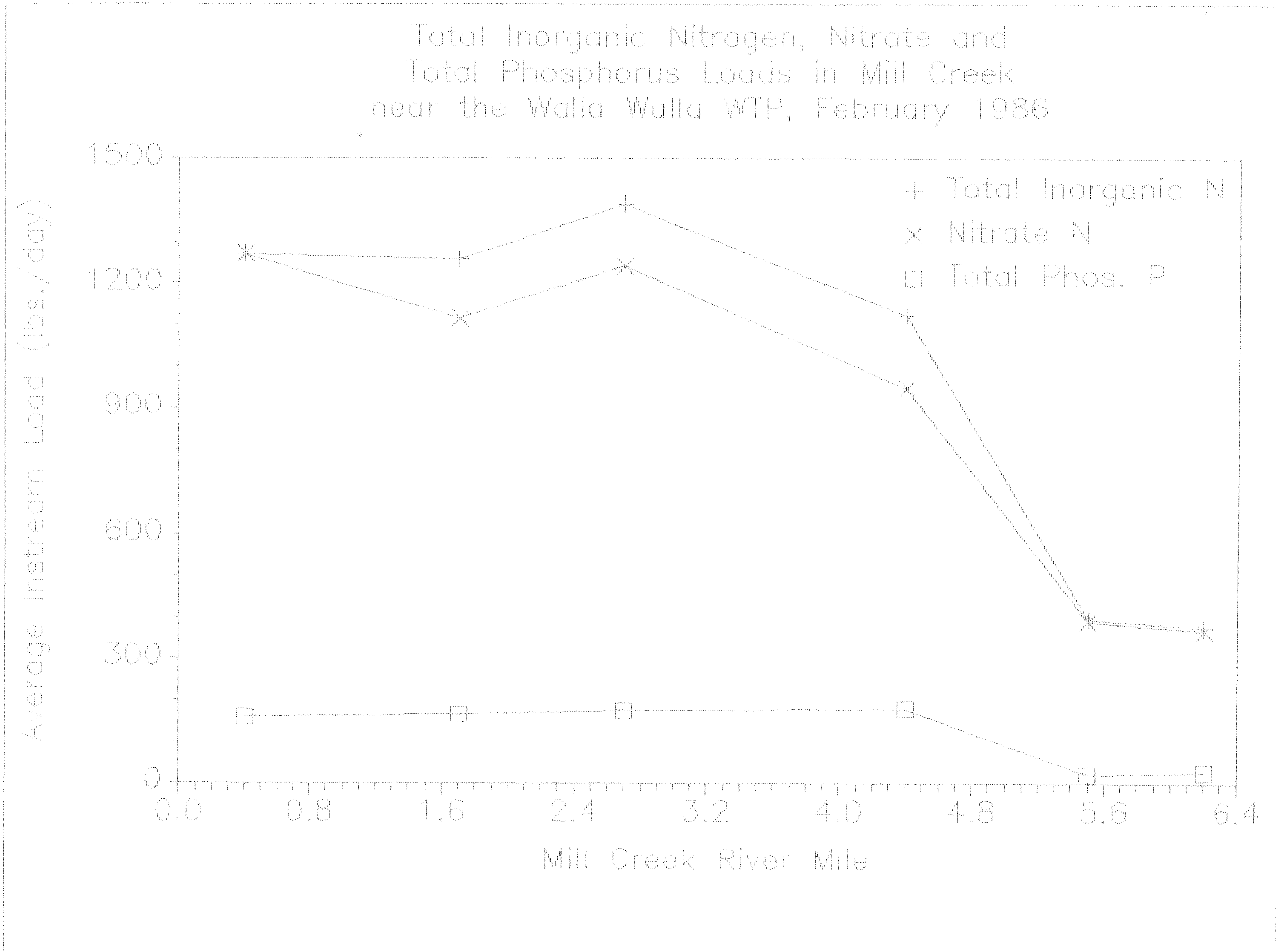
## Total Maximum Daily Load Evaluation

Singleton and Joy (1982) performed a Mill Creek total maximum daily load (TMDL) evaluation for ammonia toxicity and instream D.O. concentrations using the one-in-ten-year monthly minimum flows. These efforts aided ERO staff in extending the diversion period of the WTP effluent from Mill Creek to include the months of October and November. An additional TMDL analysis of the 1984 discharge season (December 1983 - April 1984) was performed using plant discharge monitoring reports (DMRs) values and the one-in-ten-year monthly minimum flows. The simulation results indicated the Walla Walla WTP effluent had little effect on instream D.O. concentrations during the 1984 discharge season under the current permit conditions (Joy, 1985). Since 1984, USEPA ammonia criteria and the Walla Walla WTP permit have changed so a review of the TMDL is warranted. Two sets of data were evaluated: (1) the 1986 discharge season data and (2) a maximum plant capacity, worst-case scenario.

For the first evaluation, effluent data for the 1986 discharge season (December - May) were obtained from Peterson (1987). Computer model simulations were performed using the following data:

- Minimum monthly Mill Creek discharge reported by USGS at r.m. 10 for the 1986 water year (provisional data supplied by P. Boucher, USGS-Pasco, Jan. 1987).
- Maximum effluent concentrations of BOD, ammonia, and maximum effluent temperatures; minimum effluent D.O. concentrations and average effluent flow reported in the monthly DMRs.

Figure 5.


Total Inorganic Nitrogen, Nitrate and
Total Phosphorus Loads in Mill Creek
near the Walla Walla WTP, February 1986
Total Inorganic N
Nitrate N
Total Phos. P
Average Instream Load (lbs/day)
1500
1200
900
600
300
0
0.0
0.8
1.6
2.4
3.2
4.0
4.8
5.6
6.4
Mill Creek River Mile

- Maximum monthly Mill Creek instream temperature and pH from the historical record at Ecology station 32C070 at Mill Creek and 32A070 Walla Walla River (Ecology, 1986).

- BOD and NOD rates from this study, temperature-compensated.

Computer simulation input data and selected model results are presented in Table 10. Dissolved oxygen criteria were not violated and instream ammonia concentrations at r.m. 4.4, the total-mix point, and r.m. 0.2, near the confluence with the Walla Walla River, did not exceed the new (1986) USEPA chronic and acute criteria. Criteria were calculated from instream maximum pH and temperature conditions.

The second evaluation assumed the Walla Walla WTP has reached maximum permitted capacity; i.e., average flow rate (10.8 MGD) and BOD concentration (30 mg/L) are at the limits stated in the current NPDES permit (Table 1). In addition, the following data were also used:

- The one-in-ten-year monthly low flow for Mill Creek (Table 7).

- Effluent D.O., temperature, and ammonia levels the same as Case 1.

- In-stream pH, temperature, and D.O. used in Case 1.

The input data and results of this second evaluation are presented in Table 11. Dissolved oxygen concentrations remained above Class A and B limits, and acute toxicity ammonia criteria were not violated. Estimated un-ionized ammonia concentrations at r.m. 4.4, the total mix point, in the months of December, January, and February exceeded the USEPA 4-day average criteria. The last column of values in Table 11 shows the estimated maximum effluent ammonia concentration allowed to meet the instream chronic toxicity criteria under the stated flow, temperature, and pH conditions.

These results suggest the current NPDES permit protects Mill Creek water quality against instream D.O. losses and, in most cases, against ammonia toxicity problems. Ammonia toxicity would become a problem in Mill Creek only at maximum permitted discharge of the WTP.

The eutrophication potential from instream nutrient loads in Mill Creek was identified as another concern in this 1986 study. Walla Walla WTP effluent significantly increased both nitrogen and phosphorus to Mill Creek, which already is nitrate-rich upstream of the plant. During the winter and spring, nutrients are for the most part, exported to the Walla Walla River and Columbia River. Data are not available to analyze the eutrophication impact and relative contribution of nutrients from Mill Creek to these downstream water bodies.

As a gross measure, past Water Quality Index (WQI) scores of trophic elements (nutrients) for the Walla Walla River below the Touchet River (Ecology station 32A070) were compared (Table 12).

Table 10. Variables used in the computer model simulation of Mill Creek for the 1986 Walla Walla WTP discharge period (December 1, 1985, to May 1, 1986). Selected results are also shown.

INPUT

| | Mill Creek Upstream* | | | | Walla Walla WTP** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Month | Flow | D.O. | Temp. | pH | Flow | D.O. | Temp. | $BOD_5$ | $NH_3$-N |
| Dec. | 43 | 11.7 | 9.0 | 8.0 | 6.7 | 8.5 | 10.3 | 18 | 6.5 |
| Jan. | 45 | 12.3 | 7.0 | 8.0 | 9.1 | 7.4 | 9.5 | 17 | 7.2 |
| Feb. | 87 | 12.0 | 8.0 | 8.0 | 11.6 | 8.2 | 10.3 | 20 | 4.7 |
| Mar. | 159 | 11.4 | 10.0 | 8.0 | 11.4 | 8.4 | 10.3 | 15 | 3.5 |
| Apr. | 58 | 11.4 | 10.0 | 8.0 | 9.9 | 7.6 | 11.5 | 15 | 2.8 |

RESULTS

| Month | Lowest D.O. - mg/L at (r.m.) | Maximum D.O. Loss (mg/L) | Un-ionized $NH_3$-N (mg/L) at r.m. 4.4 | Un-ionized $NH_3$-N (mg/L) at r.m. 0.2 | USEPA*** Un-ionized $NH_3$-N Criteria (mg/L) 4-day | USEPA*** Un-ionized $NH_3$-N Criteria (mg/L) 1-hour |
|---|---|---|---|---|---|---|
| Dec. | 11.0 (4.0) | 0.71 | 0.012 | 0.005 | 0.019 | 0.100 |
| Jan. | 11.2 (4.2) | 1.09 | 0.014 | 0.005 | 0.017 | 0.087 |
| Feb. | 11.3 (3.4) | 0.65 | 0.008 | 0.003 | 0.018 | 0.093 |
| Mar. | 11.1 (3.8) | 0.20 | 0.004 | 0.002 | 0.021 | 0.107 |
| Apr. | 10.8 (5.4) | 0.56 | 0.006 | 0.003 | 0.021 | 0.107 |

*Upstream data:
Flow (cfs) - minimum monthly recorded at r.m. 10 by USGS in 1985-86.
D.O. (mg/L) - 101 percent saturation at selected temperature.
Temp. & pH - maximum monthly recorded at Ecology station 32C070; 32A070.

**Walla Walla WTP data:
Flow (cfs) - average from WTP monthly DMR (Peterson, 1987).
D.O. (mg/L) - minimum from WTP monthly DMR (Peterson, 1987).
Temp. - maximum from WTP monthly DMR (Peterson, 1987).
BOD5 & NH3-N - maximum from WTP monthly DMR (Peterson, 1987).

***Criteria are calculated using pH and temperature from Mill Creek upstream input values and formula in: USEPA, 1986.

Table 11. Computer model simulation variables and selected results for Mill Creek dissolved oxygen (D.O.) and ammonia ($NH_3$-N) concentrations below the Walla Walla WTP under maximum NPDES permit conditions.

INPUT

| | Mill Creek - Upstream* | | | | Walla Walla WTP** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Month | Flow (cfs) | D.O. (mg/L) | Temp. ($^oC$) | pH (S.U.) | Flow (cfs) | D.O. (mg/L) | Temp. ($^oC$) | $BOD_5$ | $NH_3$-N |
| Dec. | 19.1 | 11.7 | 9.0 | 8.0 | 16.7 | 8.5 | 10.3 | 30 | 6.5 |
| Jan. | 57.7 | 12.3 | 7.0 | 8.0 | 16.7 | 7.4 | 9.5 | 30 | 7.2 |
| Feb. | 49.4 | 12.0 | 8.0 | 8.0 | 16.7 | 8.2 | 10.3 | 30 | 4.7 |
| Mar. | 72.4 | 11.4 | 10.0 | 8.0 | 16.7 | 8.4 | 10.3 | 30 | 3.5 |
| Apr. | 55.1 | 11.4 | 10.0 | 8.0 | 16.7 | 7.6 | 11.5 | 30 | 2.8 |

RESULTS

| Month | Lowest D.O. (mg/L) at (r.m.) | Maximum D.O. Loss (mg/L) | Un-ionized $NH_3$-N (mg/L) at r.m. 4.4 | Un-ionized $NH_3$-N (mg/L) at r.m. 0.2 | USEPA*** Un-ionized $NH_3$-N Criteria (mg/L) 4-day | USEPA*** Un-ionized $NH_3$-N Criteria (mg/L) 1-hour | Estimated Maximum Allowable $NH_3$-N Concentration in Effluent to Meet USEPA $NH_3$ Criteria |
|---|---|---|---|---|---|---|---|
| Dec. | 9.4 (4.0) | 2.3 | 0.039 | 0.011 | 0.019 | 0.100 | 3.2 |
| Jan. | 10.6 (3.7) | 1.7 | 0.019 | 0.008 | 0.017 | 0.087 | 6.4 |
| Feb. | 10.6 (3.9) | 1.4 | 0.030 | 0.006 | 0.018 | 0.093 | 5.7 |
| Mar. | 10.7 (3.8) | 0.7 | 0.010 | 0.004 | 0.021 | 0.107 | 7.4 |
| Apr. | 10.5 (4.6) | 0.9 | 0.010 | 0.004 | 0.021 | 0.107 | 6.1 |

*Upstream data:
Flow (cfs) - 1-in-10-year minimum monthly flow.
D.O. (mg/L) - 10 percent saturation at selected temperature.
Temp. & pH - maximum monthly values recorded at Ecology Station 32C070 & 32A070.

**Walla Walla WTP data:
Flow (cfs) - maximum monthly average under permit (10.8 MGD).
D.O. (mg/L) - minimum from Table 10, WTP monthly DMR (Peterson, 1987).
Temp. - maximum from Table 10, WTP monthly DMR (Peterson, 1987).
BOD (mg/L) - maximum monthly average under permit.
$NH_3$-N (mg/L) - maximum from Table 10, WTP monthly DMR (Peterson, 1987).

***Criteria are calculated using pH and temperature from Mill Creek upstream input values and formula in: USEPA, 1986. River mile (r.m.) 4.4 was end of mixing zone in the 1986 survey.

Table 12. Selected water quality index (WQI) scores for Station 32A070, the Walla Walla River at Touchet, calculated in 1980, 1984, and 1986 (Singleton, 1980; Moore, 1984; Thielen, 1986).

| Station | Year | Bacteria | Trophic | Inorganic Toxicity | Overall |
|---|---|---|---|---|---|
| Walla Walla | 1980 | 21.5 | 39.4 | 11.7 | 51.3 |
| River | 1984 | 25 | 29 | 5 | 49 |
| 32A070 | 1986 | 27 | 24 | 7 | 44 |

The 1980, 1984, and 1986 WQI trophic scores were all in the marginal category between 20 and 60; i.e., water quality standards are sometimes violated, but fishable-swimmable conditions may be obtained (Singleton, 1980; Moore, 1984; Thielen, 1986). Some improvements in the trophic and overall scores were made from 1980 to 1986.

The WQI scores indicate nutrients in the Walla Walla River drainage have declined somewhat, but the river continues to be enriched. The reasons for the apparent small improvement could be many. Certainly the recent efforts of the ERO to limit the discharge of effluent from the Walla Walla and Waitsburg (see Joy, 1986) WTPs have contributed to the improvement. A basin- or region-wide loading analysis would be necessary to evaluate the efficacy of further point-source nutrient removal versus non-point source controls.

## Conclusions

Data collected during the 1986 receiving water survey of Mill Creek below the Walla Walla WTP indicated that:

- Mill Creek water quality met Class A and B water quality criteria during the study, and probably meets criteria during the December to May permitted discharge period. The 1983 changes in the NPDES permit and in plant operation have reduced instream residual chlorine toxicity problems in the creek and may have improved the D.O. profile below the WTP.

- The evaluation of the 1986 discharge season indicates adequate instream D.O. levels were maintained, and ammonia toxicity problems were not present.

- The Walla Walla WTP continues to contribute a majority of the phosphorus load and much of the nitrogen load exported by Mill Creek during the permitted discharge season, but the seasonal removal of direct effluent discharge into Mill Creek has probably contributed to improved trophic water quality index scores downstream in the Walla Walla River.

- When the WTP reaches its maximum discharge capacity, it may create instream ammonia toxicity problems during winter low-flow conditions. Instream D.O. problems would not likely exist.

Recommendations

- Ensure proper function and maintenance of the chlorination-dechlorination monitoring unit at the WTP.
- Remove the industrial plant line drain from its discharge directly into Mill Creek.
- Continue to monitor effluent ammonia concentrations to show that low levels are maintained.

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